Sea Star Predation on Rock-Boring Bivalves

BY

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The Monterey Formation shale which forms extensive outcrops under kelp beds in southern Monterey Bay is penetrated by several species of boring bivalves of the families Mytilidae and Pholadidae. Divers examining these shale outcrops can see the protruding siphons of many of these borers and in some cases can make positive identification of the species by siphon morphology (Haderlie *et al.*, 1974). Most borers retract the siphons into the burrow when touched and a few can retract the siphons within the shell. None have methods of blocking the burrow entrance once the siphons have been withdrawn.

The sea star *Pisaster brevispinus* (Stimpson, 1857) is a common predator in the shallow subtidal water in Monterey Bay. It is seen on soft bottoms as well as on the exposed shale reefs. On soft bottoms the sea star feeds on a variety of buried bivalves by digging down to them or by extending the central tube feet downward into the sediment for as much as 17 cm and lifting the clams up to the mouth (Van Veldhuizen & Phillips, 1978). On rocky reefs the sea star often is seen over pholad and boring mytilid burrows, and when examined has its stomach everted and pressed into the opening of the burrow.

When large pieces of shale are excavated by divers, or broken free by a heavy dredge, and brought ashore for examination, it is found that at least 50% and sometimes 100% of the bivalve boreholes are empty or contain only the valves of dead borers. Some of these valves are from young immature animals.

Direct evidence of predation by *Pisaster brevispinus* on boring bivalves has been obtained recently. In an attempt to determine the growth rates of boring bivalves, a number of animals in the young, active boring stage have been removed from their natural burrows in shale, identified and measured, then re-introduced into "artificial" burrows drilled into shale similar to that from which the animals came. Species used in these experiments include *Lithophaga plumula* Hanley, 1843; *Adula falcata* (Gould, 1851); *Chaceia ovoidea* (Gould, 1851); *Netastoma rostrata* (Valenciennes, 1846); *Parapholas californica* (Conrad, 1837); *Penitella penita* (Conrad, 1837) and *Penitella gabbii* (Tryon, 1863). The experimental burrows are cylindrical (not the normal pear-shape) and fit the bivalves snugly. The open end of the burrow of each is plugged with a perforated stopper allowing the siphons to extend out into the water but preventing the animal from falling out of the burrow. The panels of shale containing the borers are then put in racks and placed on the bottom in approximately 10 m of water; each month the shale panels are recovered and x-rayed to determine growth rates of the borers. The radiation does not appear to harm the experimental animals for they remain alive and continue to bore at the same rate as control animals. During the past year mortality among all of these experimental animals has been high but the cause was unknown until racks were recovered where several *Pisaster brevispinus* were found on the shale panels in the process of feeding on representatives of all the borers named above. Careful observation revealed how the bivalves were attacked. In some cases the sea star had extended its central tube feet through the hole in the stopper, attached the tube feet to the shell of the borer, then pulled the bivalve up against the stopper until this plug popped out and the borer (and stopper!) could be enveloped by the sea star's stomach. When this tactic failed, presumably because the stopper could not be dislodged, *Pisaster* everted its stomach and inserted it through the hole in the stopper into the burrow. In these cases the stomach did not appear to enfold the borer, but digestive enzymes apparently were secreted over the borer and the bivalve digested in its own burrow. In nature, where the shape of the burrow precludes removal of the animal in one piece, this latter method of feeding is perhaps the one used and would account for the clean, empty shell valves found in many burrows.

The experiments are continuing, but now the shale panels are housed in cages that exclude predatory sea stars.

Literature Cited

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